Attorney Docket No. 566/44072

WO 2004/065154 PCT/EP2003/014724

PIVOTING SLIDING DOOR FOR VEHICLES

[0001] The invention relates to a pivoting sliding door for vehicles, particularly rail vehicles or lift cabins, having at least one door wing which, in the closed position, is arranged in the vehicle wall and which, in the open position, is arranged on the exterior side in front of the vehicle wall and in the process leaves a door opening free, driving devices as well as transversal guiding devices and longitudinal guiding devices being provided which permit a movement of the at least one door wing transversely to the vehicle wall and along the vehicle wall, the longitudinal guiding devices being moved by means of the transversal guiding devices.

[0002] A door drive of this type is known, for example, from European Patent Document EP 0 820 889 A. In the case of this door drive as well as in the case of many other door drives, almost the entire driving device, which is mounted on a carriage, moves along the transversal guiding devices, and it is therefore necessary to fix at least the longitudinal guiding devices but in most cases also all other driving components in the moved-out end position in order to ensure that the door wings do not strike by means of their interior side against the exterior side of the vehicle wall. Likewise, it has to be ensured that toward the end of the closing movement of the door wings along the longitudinal guiding devices the fixing is eliminated and the transversal guiding devices cause the pull-in movement of the longitudinal guiding devices and therefore also of the door wings and, in most embodiments, of the entire carriage.

[0003] In the state of the art, this sequence of movements is achieved by mean of a separate guide rail which is stationarily arranged with respect to the door portal and thus the car body and satisfactorily solves this problem.

[0004] Another problem is a result of the prerequisite that, in event of a power failure of the door drive, it is nevertheless ensured that the door is not opened by persons or objects

striking against the door wing. Usually, in the normal closed condition of the door, the door drive is also switched to a powerless, in the case of an electric drive, to a currentless state. In this condition, even if mechanical locks are still present, it must not be possible to open the door by exercising force upon the door wing or by operating the door handle, but the door has to remain firmly and reliably closed. When the door drive is without power, it should only be possible to open the door by operating a door emergency operating device.

[0005] In the state of the art, this requirement is met by a so-called over-dead-center mechanism, in which case a rotating or pivoting part of the door drive, which is rotatably connected with a second pivoting component, in the course of the closing movement, moves along the connection line of the axes of rotation of the two components and then takes up its end position close to this so-called dead center. When force is exercised on the door wing and thus on this pivoting part, because of the rest position of the pivoting part, this force can result only in a moment which acts upon the pivoting part in the closing direction.

[0006] As reliably as such devices prevent the unintentional or unauthorized opening of the doors, this mechanism is disadvantageous when the door is, in fact, to be opened by the door emergency operating device, particularly if this should take place by untrained persons and/or in the event of panic. Specifically, it is very probable in these situations that pressure is already exercised on the door wings in the opening direction while it is attempted to bring the driving mechanism over the dead center by means of the door emergency operating device. What is a safety feature in the normal operation now counteracts the desired opening operation and extraordinary forces are required for moving the door drive over the dead center in this case. After the dead center has been overcome, the pressing persons or objects naturally initiate and aid the opening movement.

[0007] It is an object of the invention to provide a door drive of the initially mentioned type which does not have these disadvantages but, independently of the momentary loading of the door wing, ensures an opening of the door in the event of an emergency by

means of the door emergency operating device always under the same kinematic and mainly dynamic conditions and, in the process, requires neither more space than the currently used over-dead-center mechanism, nor results in higher investment costs.

[0008] According to the invention, these objects are achieved in that the pivoting part has a guiding part interacting with a guide, and in that, in the area in which the pivoting part in the closed position of the door interacts with the door, the guide has a circular-arc section about the axis of rotation of the pivoting part.

[0009] As a result of this measure, the forces acting upon the door wing generate no moment on the pivoting part and the locking takes place in an arc section which, with respect to its size, corresponds to the arc section of conventional over-dead-center mechanisms but in a neutral manner. In order to prevent that, in the course of shocks, vibrations, inclinations of the vehicle, etc., the pivoting part reaches a position in which this neutral range is left, the pivoting part is either form-lockingly or force-lockingly held in this position, for example, by means of a spring. For the opening, only the form-locking securing has to be eliminated or the force-locking securing which always acts with a constant and low force, has to be overcome by the door emergency operation, so that the portion of the pivoting part which interacts with the guide, leaves the neutral range, whereby the opening of the door in the event of an emergency can be opened (can take place? translator) independently of the amount of the forces acting upon the door wing in the opening direction.

[00010] In the following, the invention will be explained in detail by means of the drawing.

[00011] Figure 1 is a vertical sectional view normal with respect to the exterior wall of the vehicle (?) the upper door area in the closed position of the door;

[00012] Figure 2 is a sectional view according to Figure 1 with a moved-out door wing;

[00013] Figure 3 is a view of the representation according to Figure 1 with a slightly displaced sectional plane, so that the move-out mechanism is visible; and

[00014] Figure 4 in an enlarged view of the new...**(something seems to be missing in the German - translator)** the area of the dead-center mechanism in different positions during the opening movement.

[00015] Figure 1 is a vertical sectional view in the edge area of a door having the reference number 1 as a whole. In the case of conventional doors of vehicles, for example, rail vehicles, in which the doors are arranged in the side walls of the vehicle body 6, this section therefore extends at least essentially normal with respect to the longitudinal vehicle axis. Figure 1 shows the area of the door mechanism 2 which essentially in its entirety, together with the at least one door wing 3, is arranged on a carriage 4 which is displaceable by means of rollers in guides 5 which are fixedly fastened on the vehicle body 6, as required, on a portal or frame fixedly connected with the vehicle body 6.

[00016] In the closed position illustrated in Figure 1, the exterior surface F of the door wing 3 corresponds essentially to the exterior surface A of the vehicle body 6, as customary in the case of pivoting sliding doors. The illustrated embodiment shows a telescopable door. Here, a telescope 7 consisting of at least three parts is, on the one side, connected with the carriage 4, on the other side, with the door wing 3 and therefore permits the displacement of the door wing 3 along the exterior side of the vehicle body 6. In the case of conventional doors arranged on the side of the vehicle body, the displacement direction therefore extends parallel to the longitudinal axis of the vehicle (in the case of lift doors, these relationships have a correspondingly different orientation).

[00017] This part of the door mechanism 2 is not directly related to the invention and will therefore not be discussed in detail. Thus, instead of a telescope, a different sliding system can be provided, and the like. It is only important that the door wing 3 or wings are finally mounted on the carriage 4, in which case it should not be overlooked that guides, locks, sensors, etc. are also additions to the illustrated telescope which, however, are only marginally related to the invention and will be described here only as far as required by the essence of the invention.

[00018] Figure 2 shows the door of Figure 1 in the same sectional view in the moved-out position. In this case, the carriage 4 is displaced in or along the guide 5 toward the exterior vehicle side, so that the door wing 3 also comes to be situated with its interior surface I outside the exterior vehicle side A an can be moved along the telescope 7 (normal with respect to the plane of the representation), without ramming the vehicle body 6.

[00019] Returning to Figure 1, it should be noted that, also in the case of a powerless door drive, it has to be ensured that the door wing 3 is not opened by forces acting upon it but that a locking has to exist here which can be eliminated only by the proper activating of the door drive or by operating a door emergency operating device. The locking device according to the invention which, as a whole, has the reference number 8, consists essentially of a locking lever 10 swivellably about an axis of rotation 9 disposed on the carriage 4. This locking lever 10 carries a roller 11 on one end which is displaceably or rollably disposed in a groove 12 stationary with respect to the vehicle body 6. The operation of this locking mechanism will be explained in detail below.

[00020] Figure 3 is a sectional view parallel to the sectional view of Figure 1 in the same position of the door and illustrates the actual door drive 13. In the illustrated embodiment, a gear 14 is non-rotatably connected with the output shaft of an electric motor. Another gear 14' is non-rotatably connected with the housing of the electric motor rotatably suspended about its output shaft. The gear 14' meshes with a gear 15 rotating in a non-rotatable manner with the locking lever 10 and thereby together with it about its axis of rotation 9. The gear 14 meshes with a gear 16 non-rotatably connected with a spindle 17 (Figure 2), the spindle 17, in turn, together with a nut fittingly connected with the door wing 3 being responsible for the longitudinal movement of the door wing.

[00021] The method of operation of the device is as follows: When, starting from the position illustrated in Figure 3, the motor starts to rotate in the opening direction, a guide (not shown) prevents the movement of the door wing 3 along the telescope 7 and thus any rotation of the spindle 17 and therefore also of the gears 16 and 14 so that, as a result of the moment of reaction of the motor, the latter, together with the gear 14', rotates in the

opposite direction and thus rotates the gear 15 about the axis of rotation 9. Since the gear 15 is fixedly connected with the locking lever 10, the latter swivels (clockwise in Figure 3) and thereby displaces the roller 11 in the groove 12.

[00022] The groove 12 has an at least essentially linear section 12a and, starting at a transition point 18 (Figure 4), an adjoining curved section 12b. When the door is closed (in the locked position), the roller 11 is situated in the curved section 12b. The curvature of the section 12b corresponds at least essentially to the curvature which a circle has in the center at the point at which the axis of rotation 9 is situated when the door is closed. Thus, at the start of the rotating movement of the locking lever 10 about is axis of rotation 9, a movement of the roller 11 occurs in the groove which is adapted to the shape of the groove 12b, this movement not causing any noticeable reaction forces between the roller and the wall of the groove. Since there are no such forces, no displacement of the carriage 4 occurs in the guides 5.

[00023] When, as a result of the progressing rotation of the locking lever 10, the roller 11 arrives in the linear section 12a of the groove 12, it attempts to continue the rotating movement and in the process presses against the ("lower" or "right") groove wall, which leads to a reaction force upon the roller and thus upon the locking lever. As a result, the axis of rotation 9 and with it the entire carriage 4 together with the door drive 13 and the door mechanism 2 and the door wing 3 is displaced (move-out movement) until finally the situation of Figure 2 has been reached.

[00024] This move-out movement is shown in greater detail in Figures 4 to 9, where, on the one hand, the scale of the representation is enlarged and, on the other hand, all components situated on the door side of the carriage were omitted for reasons of clarity. The locking lever 10 has a different shape than in Figures 1 to 3, which is not important, however. The position of the individual parts in Figure 4 now corresponds to that in Figure 1: The carriage 4 is in the position in which it is pushed the farthest into the interior of the vehicle body; the locking lever 10 takes up a position which cannot be rotated counterclockwise or can hardly be rotated farther; and the roller 11 is situated in the curved part 12b of the

connecting link or of the groove 12 at some, although narrow distance from the transition point 18.

[00025] In Figure 4 and in the figures which follow, the shape of the groove 12 is indicated by the center line 12'; the transition between the linear section 12a and the curved section 12b is marked by a small circle around the transition point 18. It is also clearly illustrated that the center line 12' of the groove 12 in the curved section has the shape of a circular arc around the axis of rotation 9 in this position of the carriage 4. Furthermore, it is shown that the center 11' of the roller 11 is situated already in the curved section 12b and therefore has a distance from the transition point 18; in the illustrated example, the indicated 5E.

[00026] The special significance of this shaping and this position is now that forces acting upon the door wing - this does not apply to driving and guiding forces during the operation but to forces which are exercised intentionally or unintentionally upon the door wing by passengers (impacting during cornering, leaning by persons, use of standing room, acts by vandals, pressure differences when traveling through tunnels or during passing of trains, etc.) if the resultant force is aimed at least approximately horizontally upon the door wing toward the outside - exercise a force upon the carriage 4 in the direction of the arrow H. Vertical components, which are transmitted to the carriage 4, are taken over by the guide 5 in which the carriage is disposed by means of rollers in the illustrated embodiment.

[00027] The only reaction forces which can act against the horizontal force H are the forces occurring between the roller 11 and the wall groove 12. These may occur (friction neglected) only normally on the joint tangential plane in the contact area between the surface of the roller 11 and the surface of the groove wall (direction N) which, however, because of the described geometrical conditions, coincides with the straight connection line in the direction R between the axis of rotation 9 and the axis 11' of rotation of the roller: R=N. This means that, also when large forces H occur, no moment is created at the locking lever 10, so that the carriage cannot start moving and therefore the door wing 3 can also not move in the opening direction. The horizontal component of the normal force

N balances the applied horizontal force H: The door is locked.

[00028] When the normal opening movement is now initiated, as illustrated in Figure 5, by means of the torque exercised on the locking lever 10, the axis 11' of rotation of the roller 11 arrives at the transition 18 between the linear section 12a and the bent section 12b of the groove 12 and thus at the boundary of the area in which the above-mentioned facts apply. During the rotation about the, in the illustrated embodiment, 5E between the end position according to Figure 4 and the neutral limit position according to Figure 5, the carriage, indicated at the axis of rotation of the motor (Figure 3), carries out no lift; that is, that this movement is not made more difficult by any large forces H in the horizontal direction.

[00029] This is an important contrast to the previously known over-dead-center mechanisms, in the case of which, in the course of the movement from the locked end position to the boundary position, it had always been necessary to "overcome the dead center", which, applied to the illustrated embodiment, corresponds to a low but still noticeable movement of the carriage 4 against the force 11, so that, in the event of panic or simply high forces, this overcoming of the dead center is made difficult and in the case of a manual opening, specifically when panic occurs, is made almost impossible.

[00030] Figure 6 illustrates how, during the entry into the linear section 12a of the groove, the lift movement starts, on the one hand, and, on the other hand, as a result of the gaping of the normal force N between the roller 11 and the groove wall, on the one hand, and of the radial direction R as the connection line between the axis of rotation 9 and the roller axis 11' by the horizontal force H, a torque, caused by the tangential force T upon the locking lever 10, acts in the opening direction.

[00031] In the case of a further progressing lift, Figure 7 shows the locking lever in an almost normal direction to the guide 5; Figure 8 shows the situation in the case of a more rotated locking lever 10 which has started to move out of the groove 12 again.

[00032] Figure 9 finally shows the fully moved-out end position. The roller 11 again arrives at the or in the curved area 12b, but this is not important with respect to the locking

because of the completely displaced position of the axis of rotation 9 which moves along with the carriage 4.

[00033] In the course of the move-out movement illustrated in Figures 4 to 9, the displacement of the door wing 3 also starts along the telescope 7 (Figure 1). The sequence of these two movements is caused in a known manner by a guide which is fixedly arranged with respect to the vehicle body 6 and which also (unless other stop mechanisms, for example, in the guide 5 are provided) causes the end of the move-out movement of the carriage 4. As a result of this fixing of the carriage 4, the moment, which is required for rotating the spindle 17 (Figure 2), becomes smaller than the holding moment by the fixed carriage acting upon the motor housing (gear 14'), so that the rotating movement of the spindle starts. Naturally, it is also conceivable to implement the displacing movement of the door in a different manner. The plurality of the known drives can be combined together with the locking device according to the invention for the door in the closed position.

[00034] The closing movement of the door takes place in precisely the reverse sequence as previously the opening movement: First, by means of the motor, whose housing and the gear 14' connected therewith is fixed, a rotation of the spindle is caused in the closing direction; when the door wing approaches its closed position, the guide (not shown), which is fixedly connected with the vehicle body 6, has the result that the carriage 4 can be moved in the direction away from the exterior vehicle side A, whereupon the moment of reaction at the gear 14' initiates this movement which now, in the sequence of Figures 9, 8, 7, 6, 5 and finally 4, reestablishes the closed position in the locked position.

[00035] As illustrated here by a comparison between Figures 5 and 4, during the movement of the connection line between the axis of rotation 9 and the roller axis 11' by way of the transition point 18 of the guide 12, the coinciding of reaction forces originating from the horizontal force H and the radial force R with the resulting normal force N is ensured so that a locking takes place without the exceeding of a dead center.

[00036] As initially mentioned, the position of the locking lever 10 is secured in the position illustrated in Figure 4, for example, by a weak torsion spring in the bearing of the locking lever 10 bout the axis 9 or by a form-locking locking by a pin or the like, which projects into the groove at the fitting point. Such securing devices are also necessary in the case of the known excess pressure mechanisms, because the latter reliably remain in the locked position only in the case of a continuously applied force in the opening direction, while, in the completely unloaded condition, they may unlock in an undesirable manner as a result of vibrations or the like.

[00037] Concerning the different shape of the locking lever in Figures 1 to 3 and Figures 4 to 9, it should also be noted that, in Figures 1 to 3, this lever is also used for operating a holding device for the door wing 3 arranged at the lower door end. As illustrated in Figures 1 and 2, in the course of the opening of the door, the upper linkage point of the operating rod 19 moves upward, so that a holding or release movement can be derived therefrom. It is also conceivable to construct this operating lever 19 as part of an emergency operating device. As a result of such an emergency operating device, the moment required for the opening can be applied directly to the locking lever 10, independently of the actual motor.